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UNITED STATES

United States Patent Application

Title: PREMIXED FUEL BURNER ASSEMBLY

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- 1 -

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This application claims the benefit under 35 U.S.C. 119(e) of U.S. Provisional
5 Application No. 60/442,514, filed January 27, 2003.

FIELD OF THE INVENTION

This invention relates to fuel burner equipment and more
10 particularly to a premixed fuel burner assembly.

BACKGROUND OF THE INVENTION

Premixed fuel burner assemblies are used with various heating
equipment such as boilers, commercial hot water headers, fuel barbeques, and
15 the like. Fuel burners are devices into which a flow of combustible fuel (usually
gas) is introduced into a mixing chamber, where it is mixed with air supplied in a
suitable proportion to the combustible gas. After mixing, the mixture of
combustible fuel and air exits the mixing chamber through burner ports where it
is ignited and burnt.

20 Specifically, a typical premixed fuel burner assembly consists of a
hollow burner body having a closed end and an open end into which the
premixed fuel/air flows. The burner body includes a porting area that consists of
burner flame port perforations (i.e. slots and/or holes). Within the burner body is
a venturi tube that typically contains a multiplicity of holes through and out which
25 the fuel and air mixture from the interior of the body flows. Fuel and air are both
provided into the boiler body through the venturi tube. Specifically, fuel is
provided into the venturi tube through a fuel nozzle and air is provided around the
fuel nozzle. Fuel and gas are mixed to produce a combustible mixture which
subsequently is passed through the burner body and ignited to produce a burner
30 flame that, in the case of a water heater, is applied to the a heat exchanger of the
boiler.

- 2 -

Conventional premixed fuel burner assemblies produce short flames that are just beyond or above the burner porting area. Normally the mixture has 30 percent excess air so as to provide cleaner combustion products. At loadings (i.e. heat per unit area) below approximately 6 kilowatts per square decimeter, the burner port surface will be radiant since the velocity of the mixture is low resulting in the flame being positioned on or closely adjacent to the surface. This gives rise to problems of thermal fatigue and high temperature oxidation of the burner porting surface, and potential flashback of the flame into the burner body. At higher loadings (e.g. 12 kilowatts per square decimeter and above) the increase in volumetric flow is such that the velocity of the mixture may be increased to the point where the flame front is further from the burner porting surface resulting in a relatively cool porting surface. However, at high loadings if the amount of excess air is not or cannot be controlled, overheating of burner porting surface can still result when there is inadequate excess air (i.e. when there is too much fuel in the air/fuel mixture) since in such a case the flame will sit on the surface of the burner increasing the temperature. As is conventionally known, when the burner body becomes too hot (e.g. 2000 degrees Celcius) the fuel burner assembly can suffer failures, melting and irreversible damage.

Various types of fuel burner assemblies have been developed to attempt to maintain the flames above the surface of the outer cylinder by operating at high loadings (i.e. high fuel/air velocities) while at the same time maintaining a proper mix of fuel and flame stability. For example, U.S. Patent No. 6,461,152 to Wood et al. discloses a tubular burner consisting of a cylindrical tubular body into which a distributor component can be fitted. The distributor is substantially the same axial length as the tubular burner body but of a smaller cross-sectional dimension than said body so to allow for easy insertion. The distributor divides the burner body into an upper and a lower chamber. The distributor has a first tubular portion and a second extension portion each of which is provided with axially aligned flanges having a number of perforations. While this assembly achieves a reasonable distribution of air and fuel streams prior to delivering the fuel/air mixture to the porting area of the tubular burner, the

- 3 -

construction and assembly of this burner is expensive, as is the manufacture of the various components involved in the construction.

SUMMARY OF THE INVENTION

5 The invention provides in one aspect, a premixed fuel burner assembly, comprising:

10 (a) a hollow tubular burner body having a longitudinal axis, said burner body having a longitudinal porting area having formed within a plurality of radially formed slots, said burner body having a first end and a second end;

 (b) a hollow tubular venturi tube positioned within said burner body along said longitudinal axis extending from said first end;

15 (c) a distribution plate having a mid-section and longitudinal flanges, said flanges being coupled to the inside surface of burner body, said mid-section having a plurality of holes formed within, and said distribution plate being positioned within said burner body such that the holes of distribution plate are positioned adjacent to the radially formed slots within said burner body.

20 The invention provides in another aspect, a method of making a fuel burner assembly, said method comprising the steps:

 (a) forming a tubular burner body;

 (b) cutting a plurality of radial slots formed within said tubular body;

25 (c) forming a hollow tubular venturi tube and positioning it within said burner body along said longitudinal axis extending from said first end;

 (d) forming a distribution plate with a mid-section and longitudinal flanges;

 (e) cutting a plurality of holes within the mid-section; and

- 4 -

5 (f) coupling the flanges of the distribution plate to the inside surface of burner body such that the distribution plate is positioned between the inside surface of the burner body and the venturi tube and such that the holes within the mid-section are positioned adjacent the slots of said burner body.

Further aspects and advantages of the invention will appear from the following description taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10 In the accompanying drawings:

FIG. 1 is a side perspective view of the premixed fuel burner assembly of the present invention;

15 FIG. 2 is a side perspective view of the premixed fuel burner assembly of the present invention with internal components of the premixed fuel burner assembly being shown in dotted outline;

FIG. 3 is an radial cross-sectional view of the premixed fuel burner assembly of FIG. 2 taken along line B – B' of FIG. 2; and

20 FIG. 4 is a longitudinal cross-sectional view of the pre-mixed fuel burner assembly in use illustrating the position of flames in respect of the burner body.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1, 2 and 3, illustrated therein is a premixed fuel burner assembly 10 made in accordance with a preferred embodiment of the present invention. Fuel burner assembly 10 consists of a burner body 12, a
25 conventional fuel/air mixing venturi tube 14 (FIGS. 2 and 3), and a distribution plate 16. Venturi tube 14 and distribution plate 16 are positioned within burner body 12 and together insure good mixing of the fuel and air as the fuel/air

- 5 -

mixture is urged through burner body 12 and an even and raised flame profile on the porting area of burner body 12 to minimize thermal fatigue and oxidation effects on burner body 12. Additionally, since fuel burner assembly 10 generates a high velocity of a well mixed fuel/air stream throughout the fuel burner assembly 10 such that excess air is evenly provided throughout the mixture, flame flashback and instability effects are inhibited.

Burner body 12 is a hollow cylindrical tube having preferably having a circular cross-section. However, it should be understood that burner body 12 could also have various shaped cross-sections (e.g. oval, rectangular, polygon, etc.) depending on the particular use of burner body 12. For example, in the case where burner body 12 has an oval cross-section, the height of the combustion chamber can be minimized by orienting the minor axis in the vertical direction. Burner body 12 has a longitudinal axis A and is axially aligned with venturi tube 14 and distribution plate 16 as will be described. Burner body 12 is closed at one end 20 and open at the other end 22. The closed end 20 and open end 22 are formed using conventionally known crimping techniques. The open end 22 is adapted to receive and mount one end of venturi tube 14 and distribution plate 16 as will be described. The closed end of burner body 12 is closed so that burning is confined within burner body 12. It should be understood that burner body 12 may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Finally, burner body 12 should be understood to be any burner having an outer surface that defines an internal cavity in which venturi tube 14 and distribution plate 16 can be disposed.

As shown, the surface of burner body 12 includes a porting area 17 within which are formed a plurality of burner ports 18. Burner ports 18 consist of a plurality of small radially oriented rectangular slots arranged in an offset manner as shown. Burner ports 18 keep the flame front 50 (FIG. 4) off of the surface of the deck while maintaining a stable flame which results in the surface of the burner body 12, and in particular, the porting area 17 being maintained at a relatively low temperature. Burner ports 18 are of an appropriate size for a particular application. For example, if fuel burner assembly is to be used within a

- 6 -

hot water heater, burner ports **18** may be approximately 6 mm by 0.75 mm. Due to the equal configuration of burner ports **18** as well as the even distribution of mixed fuel/air above distribution plate **16** as will be discussed, an equal flame **50** height along the entire porting area **17** is provided (see FIG. 4).

5 Referring to FIGS. 2 and 3, venturi tube **14** is a hollow cylindrical tube having either a circular or oval cross-section. It should be understood that venturi tube **14** may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Venturi tube **14** is axially aligned with the longitudinal axis of burner body **12** and positioned within burner
10 body **12** along a short longitudinal section of burner body **12** from the open end **22** into the area within burner body **12**. The remainder of venturi tube **14** extends out of the open end **22** of burner body **12** and out of the combustion chamber and being attached to and spaced from a gas injection member (not shown) connected to a source of gas (e.g. natural gas outside of the water header).

15 The exterior surface of venturi tube **14** where it enters the combustion chamber is sealed using an end cap **42**. Flange **41** (FIGS. 1 and 2) is adapted to be fastened to an appliance in which fuel burner assembly **10** is used. End cap **42** is preferably formed using beading and crimping methods to eliminate the necessity of welding, although welding can also be utilized.
20 Accordingly, air is only provided through the venturi tube **14**. Preferably, three spacers (not shown) are used to maintain a centered longitudinal position for venturi tube **14**. A mixture of fuel and air is provided to venturi tube **14** through a fuel nozzle (not shown). The length and diameter of venturi tube **14** are selected to provide for proper mixing of fuel with air. Specifically, venturi tube **14** is sized
25 so that more air than is required for combustion is provided (e.g. 30%) to reduce the maximum flame temperature and to provide cleaner combustion products (i.e. lower levels of toxic NO_x and carbon monoxide emissions). such that a high velocity of air/fuel mixture is provided to the area within burner body **12** underneath the porting area **17** of burner body **12**.

- 7 -

Referring to FIGS. 2 and 3, distribution plate 16 is a long plate having a C-shaped cross-section. Distribution plate 16 is adapted to axially aligned with the longitudinal axis of burner body 12 and to fit within minor section of burner body 12 directly underneath longitudinal porting area 17. It should be understood that distribution plate 16 may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Distribution plate 16 has two longitudinal folded flanges 24 and 26 and a mid-section 26. A plurality of evenly spaced holes 28 is formed within the surface of mid-section 26. Longitudinal folded flanges 24 and 26 (FIG. 3) are shaped to contact the inside surface of burner body 12 along its longitudinal length as shown.

The exterior surface of flanges 24 and 26 of distribution plate 16 are coupled to the inside surface of burner body 12 using an appropriate conventionally known welding technique (e.g. spot welding or seam welding techniques). Flanges 24 and 26 are coupled to the inside surface of burner body 12 such that the mid-section 26 of distribution plate 16 is positioned underneath the longitudinal porting area 17 of burner body. Specifically, distribution plate 16 is positioned within burner body 12 such that the plane defined by the holes 28 within mid-section 26 of distribution plate is oriented along and collinear with the longitudinal axis of burner body 12 and such that holes 28 are positioned adjacent the burner ports 18 within porting area 17.

Holes 28 on distribution plate 16 are of variable size. The size of each hole 28 varies according to its position on distribution plate 16. Specifically, holes 28 are largest at one end of distribution plate 16 and smallest at the other end. The end at which holes 28 are the largest is intended to be located at the open end of fuel burner assembly 10 and the end at which holes 28 are smallest is intended to be located at the closed end 20 of fuel burner assembly 10. Preferably, holes 28 are one of two sizes, where larger sized holes 30 clustered at the open end 22 and a small sized holes 32 which extend the length from the end of the cluster of the larger sized holes 31 until the closed end 20. It should be understood that while only two sizes of holes are shown and described, any form

- 8 -

of gradient of hole size is contemplated. Specifically, in between the ends of distribution plate 16, holes 28 can be gradually reduced in size as they traverse from the open end 22 of fuel burner assembly 10 to the closed end of fuel burner assembly 10. Further, various patterns or configurations of holes 28 are also contemplated depending on the particular functionality required by a particular application.

The holes 28 within distribution plate 16 allow for improved mixing of fuel and air between the distribution plate 16 and the inside surface of burner body 12 (i.e. "mixing chamber D" as shown in FIG. 4). The presence of larger holes at the closed end 20 and smaller holes at the open end 22, provides for a higher degree of turbulence at the open end 22 of burner tube 12 and a lower degree of turbulence at the closed end 20. Since fuel and air streams are being discharged at the open end 22, increased amount of turbulence is needed at the open end 22. By directing an increased amount of turbulence to the open end 22 part of fuel burner assembly 10, an improved efficiency in mixing of fuel and air streams can be achieved. In prior art fuel burner assemblies, turbulence is provided evenly at both open and closed ends of the burner assembly, resulting in unnecessary turbulence at the closed end and not enough turbulence at the open end for optimal fuel and air mixing. Accordingly, the specific arrangement of holes 28 within distribution plate 16 in conjunction with the shortened extent of venturi tube 14 together produce a substantially evenly distributed mixture of air and fuel within mixing chamber D and accordingly even and highly set flames 5 above porting area of burner body 12. Further, this is provided without a high pressure drop.

FIG. 4 is a cross-sectional view of fuel burner assembly 10 illustrating how flames 50 sit above the porting surface 17 of burner body 12 at a distance represented by "C". This is the case due to the improved mixing capability of fuel burner assembly 10 and accordingly it's ability to maintain flame stability at high fuel/air mixture velocities (i.e. high loading). Specifically, the volume defined by between the top surface of distribution plate 16 and inside surface of burner body 16 constitutes a mixing chamber D which receives a

- 9 -

mixed air/fuel stream through holes 28 in mid-section of distribution plate 16 and which redistributes the mixed air/fuel stream through burner ports 18 in burner body 12. The mixing chamber constitutes a volume that is semi-circular in cross-section and which runs the entire length of burner body 12. The holes 28 within
5 (smaller holes 32 are shown in FIG. 4 since the closed end 20 section of fuel burner assembly 10 is shown) distribution plate 16 allow for improved mixing of fuel and air within the mixing chamber D. Further, by using larger holes at the closed end 20 and smaller holes at the open end 22, increased turbulence is produced at the open end 22 of burner tube 12 as compared to the closed end
10 20. Accordingly, flame flashback is prevented since distribution plate 16 physically prevents fuel from coming back to venturi tube 14.

Accordingly, fuel burner assembly 10 is designed to maintain flames above the surface of burner body 12 by operating at high loadings (i.e. high fuel/air velocities) while at the same time maintaining a proper mix of fuel
15 and flame stability. Fuel burner assembly 10 achieves these features through the use of a particularly perforated distribution plate 16 (i.e. variable sized holes 28) as discussed in conjunction with a partially extending venturi tube to optimize the mixing process between fuel and air streams.

As will be apparent to persons skilled in the art, various
20 modifications and adaptations of the structure described above are possible without departure from the present invention, the scope of which is defined in the appended claims.